



**SOLDERLESS  
WRAPPING  
MANUAL**

**μ-PAC 5 mc Digital Logic Modules**

**Honeywell**



**COMPUTER CONTROL  
DIVISION**

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M-1100

**Instruction Manual**  
**SOLDERLESS WRAPPING**  
**of**  
 **$\mu$ -PAC DIGITAL MODULES**

**November 1967**

**Honeywell**  
 **COMPUTER CONTROL**  
**DIVISION**

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## SECTION I INTRODUCTION

### 1.1 SCOPE

This manual contains instructions for reliable interconnection of the  $\mu$ -PAC<sup>TM</sup> digital modules manufactured by Honeywell Inc., Computer Control Division. Section I contains introductory information on solderless-wrapped connection techniques in general and the application of these techniques to the interconnection of  $\mu$ -PAC digital modules.

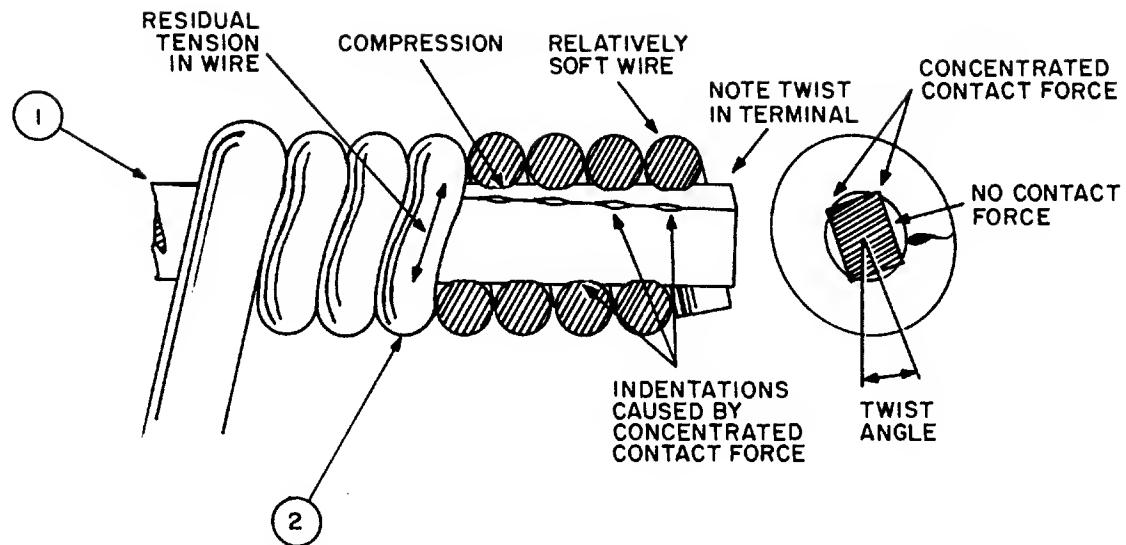
Section II describes "Wire-Wrap" tools and accessories required for wrapping and discusses the operation of these tools. Section III provides step-by-step procedures which will enable the operator to wrap efficiently and reliably. Section IV contains information for acceptance testing the interconnections. Included are a visual inspection procedure for reliability check and optional additional tests. Section V contains information on solderless wrapping by means of automatic machinery.

### 1.2 SOLDERLESS WRAPPING TECHNOLOGY

Solderless wrapping refers to the mechanical wrapping of silver-plated copper conductor around a terminal pin. The wrap is accomplished with a wrapping gun driven manually, electrically or by air. A specific bit and sleeve is required for each given wire gage. The wrapping operation results in the wire being stressed and the pins compressed so that residual tension keeps the wire on the pin (see Figure 1-1). The wire cuts into the pin and the pin, in turn, cuts into the wire, resulting in two flat, mating surfaces at the point of contact.

The resultant connection is mechanically stable and highly resistant to physical disturbances, such as jarring or flexing of the wire. As the

\*"Wire-Wrap" is a registered trademark of the Gardner-Denver Co., Grand Haven, Michigan, used to identify tools for solderless wrapping.



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Figure 1-1. Solderless-Wrapped Connection Principle

connection ages, solid-state diffusion of the wire and terminals at the point of contact results in a stronger mechanical connection.

### 1.3 SOLDERLESS-WRAP $\mu$ -BLOC MOUNTING ASSEMBLIES

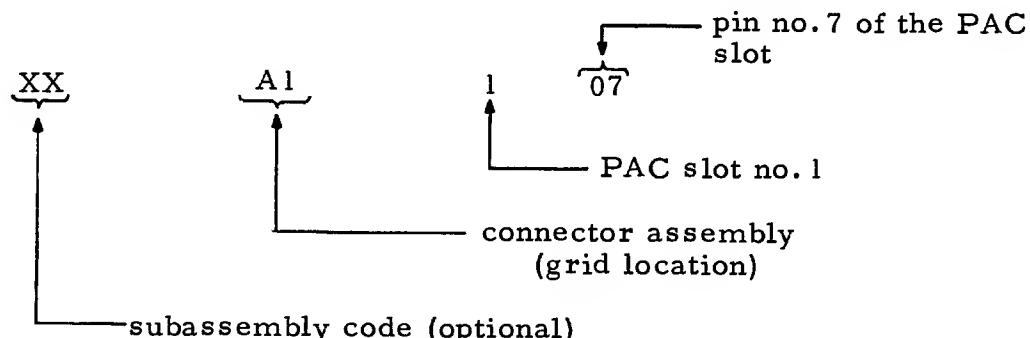
Each Honeywell solderless-wrap  $\mu$ -BLOC mounting assembly consists of an array of connector assemblies mounted on a connector plane. As many as eight  $\mu$ -PACs can be inserted into each connector assembly. For a complete description of  $\mu$ -PACs and associated mounting hardware, refer to the Instruction Manual on  $\mu$ -PAC Integrated Circuit Modules.\*

Each connector assembly, containing eight PAC slots, is separated from adjacent connector assemblies by open channels. These channels can be used for routine cable harnessing. One of the channels is also used for power supply terminals. The connector plane is prewired for +6V and ground from the power supply terminal to the appropriate pins of each PAC slot. PAC slots that require -6V must be wired directly from the -6V terminal to the appropriate PAC slot and PAC pin. The connector plane channels can also be used for routine cable harnessing.

Each connector assembly (eight PAC slots) contains 8 groups of 34 terminals. These pins, totaling 272, are identified in the following paragraphs and shown in Figure 1-2.

### 1.4 PIN IDENTIFICATION

An alphanumeric code, consisting of at least five characters, is recommended to identify each connector pin. Refer to Figure 1-2 and the sample designation below for a description of the location system.



\*Honeywell Document No. 130071369 (two volumes) M-99 and M-135.

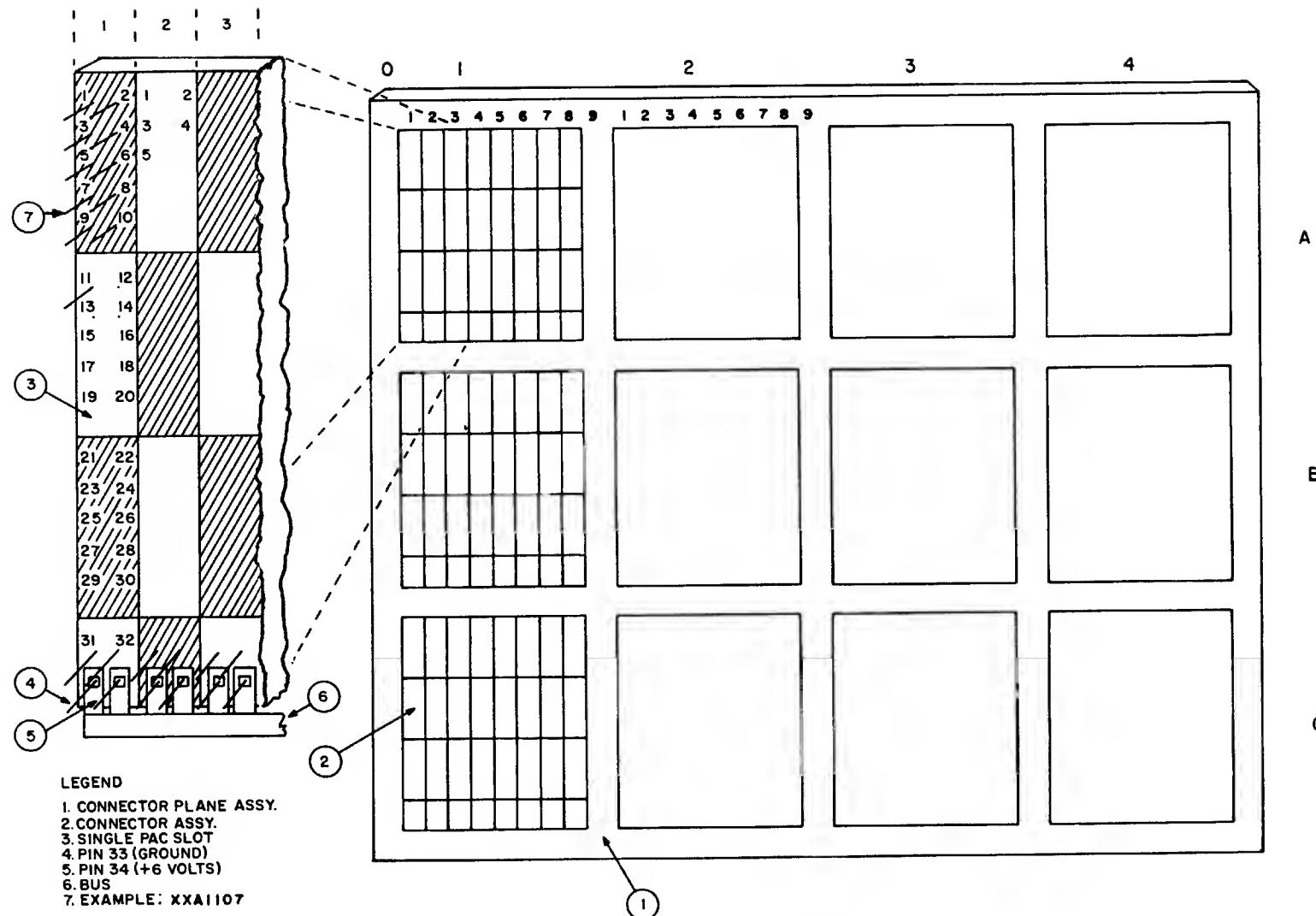


Figure 1-2. Connector Plane Assembly

a. Subassembly Code: These are two optional characters that may be employed when more than one connector plane is to be wired in the system.

b. Connector Assembly Code: This is a grid location code to identify a connector assembly on the connector plane. The digit 0 is used to identify the leftmost channel adjacent to a connector assembly. This location area may contain power supply input terminals. Note, power supply terminals in other channel areas are identified as PAC slot position 9. See paragraph c below.

c. PAC Slot Code: This number, for positions 1 through 8, is marked directly on the connector. Slot position 9 is the channel area directly to the right of the connector assembly.

d. Pin Number Code: The  $\mu$ -PAC pin numbers are marked directly on the connector assembly. The power supply terminals in the channel areas should be designated 01, 02, etc., starting with the uppermost pin of each grid location area.

## 1.5 WIRE

Wire to be used on the connector planes should be No. 30 AWG. This wire can be procured from any of several manufacturerers, but extensive testing has indicated that the following are the most satisfactory.

<u>Type</u>	<u>Manufacturer</u>
Milene "B"	W. L. Gore
FH4	Acme Wire Co.

## 1.6 POWER DISTRIBUTION

Power voltages are distributed to each  $\mu$ -PAC by means of a busbar system. This consists of two flat conductor strips (bus), one for ground potential and one for +6 volts. The strips are connected to pins 33 (ground) and 34 (+6 volts).

## SECTION II TOOLS

The tools required to make satisfactory wrapped connections are available in kit form. These tools are listed in Table 2-1. In addition to the tools required, the kit also contains a dummy connector which will enable the operator to practice solderless wrapping before applying the technique to the final product. This section of the manual describes the use of these special tools and provides recommendations for setting up a solderless-wrapping work station.

Table 2-1.  
Recommended Tools

Description	Identification	Description	Identification
Bit	Gardner-Denver No. 504221	Dressing fingers	See Fig. 2-4.
Sleeve	Gardner-Denver No. 500350	Tweezers	Commercial
Wrapping tool (hand operated)	Gardner-Denver Model 20557-29	"Wire-Wrap" aid	See Fig. 2-4.
Stripper	Computer Control Company No. B008980	Wire cutter	See Fig. 2-2.
Unwrap tool	Gardner-Denver No. 505084 (LH)	Dummy connector	See Fig. 2-5.
		6-inch rule	Commercial
		Precut wire	See Para. 2.2.11.

### 2.1 WRAPPING TOOL (BATTERY OPERATED)

The battery-operated tool is illustrated in Figure 2-1 and is available as an option with the "Wire-Wrap" kit. Approximately 4000 connections can be made before it is necessary to recharge the battery. The battery can be recharged by detaching it from the tool and plugging it into any 110-volt ac wall socket.

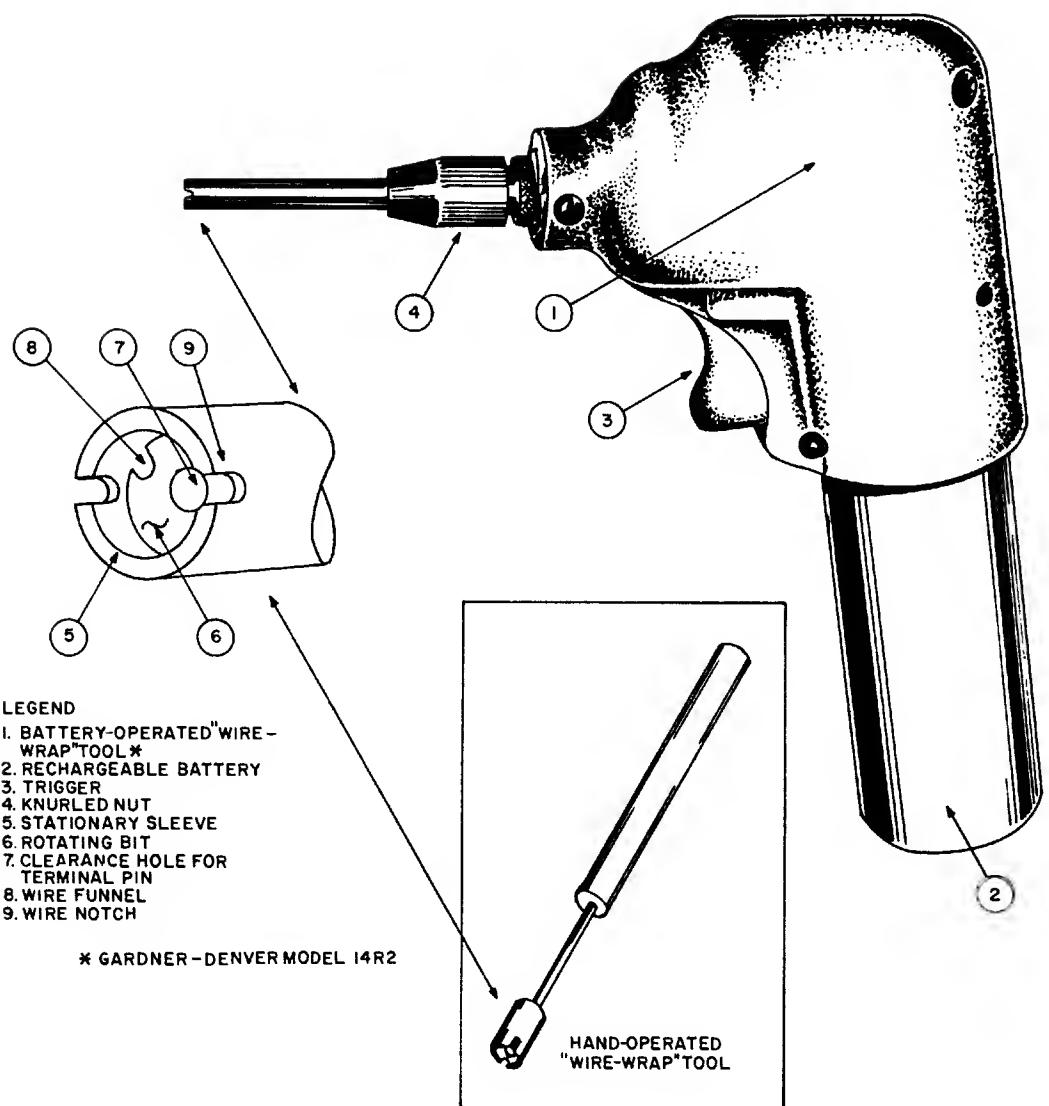


Figure 2-1. Wrapping Tool

## 2.2 WRAPPING BIT

The bit is part of the assembled wrapping tool shown in Figure 2-1. When the tool is activated, the bit rotates inside the sleeve and around the terminal pin.

## 2.3 SLEEVE

The sleeve is also part of the wrapping tool and is illustrated in Figure 2-1. The sleeve is stationary, being clamped in place by a knurled nut (4, Figure 2-1).

## 2.4 HAND-OPERATED WRAPPING TOOL

This tool (Figure 2-1) is recommended for use when a small number of wrapped interconnections are to be made. Both sleeve and bit are stationary and are rotated by hand when wrapping the wire around the pin.

## 2.5 STRIPPER

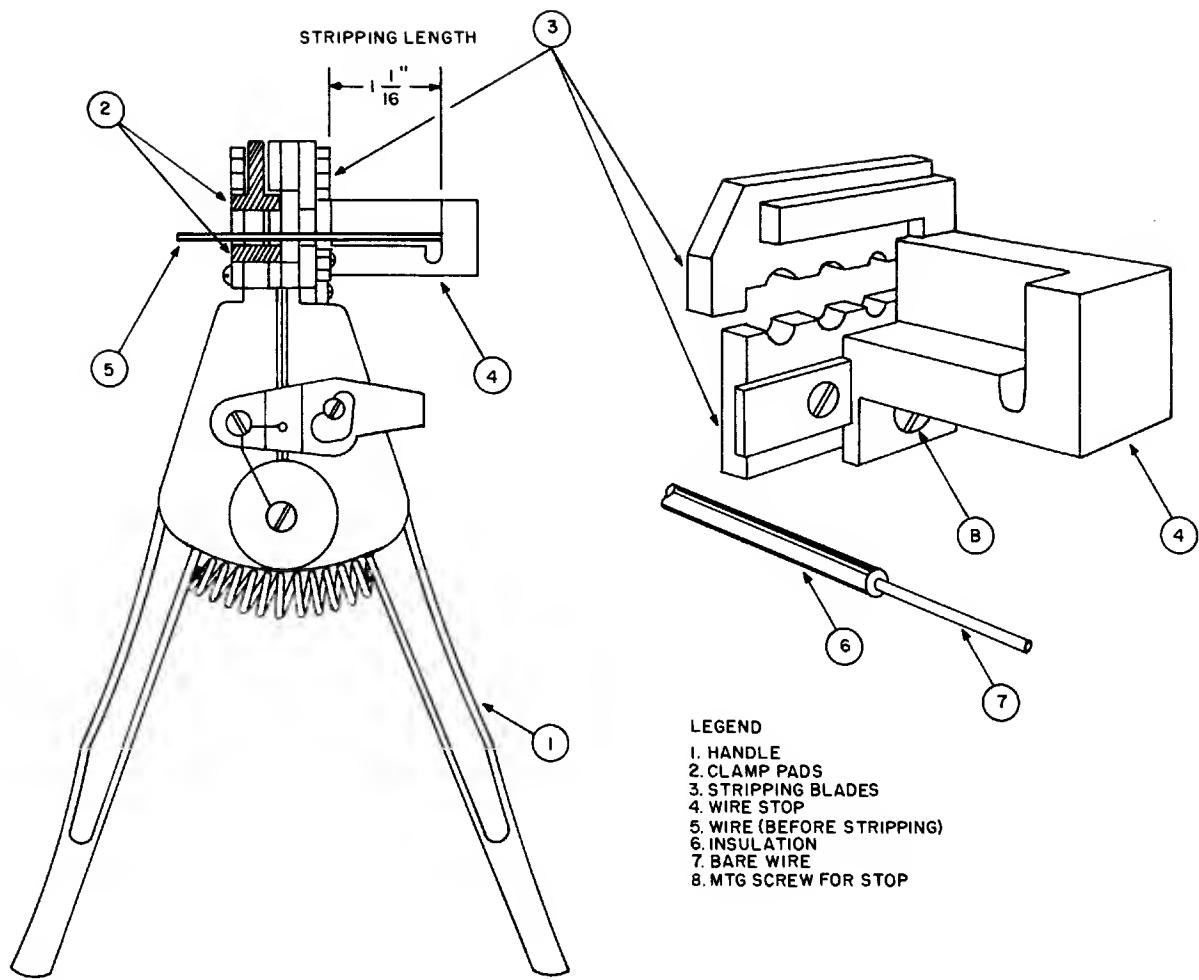
The stripper is used to remove insulation from the ends of insulated wire (see Figure 2-2). The wire is inserted between the clamp pads and upper and lower stripping blades until the end of the wire comes up against the adjustable wire stop. When the handles are squeezed, the upper clamp pad moves down, clamping the wire down on the lower pad. At the same time, the upper stripping blade clamps the wire insulation on the lower stripping blade. When the handles are squeezed further, the clamp pads move away from the stripping blades, pulling the insulation from the wire.

## 2.6 UNWRAP TOOL

This tool is used to remove wrapped connections (see Figure 2-3). When the tool is placed on the wrapped pin and manually rotated in a counterclockwise direction, the wire will unwind from the post.

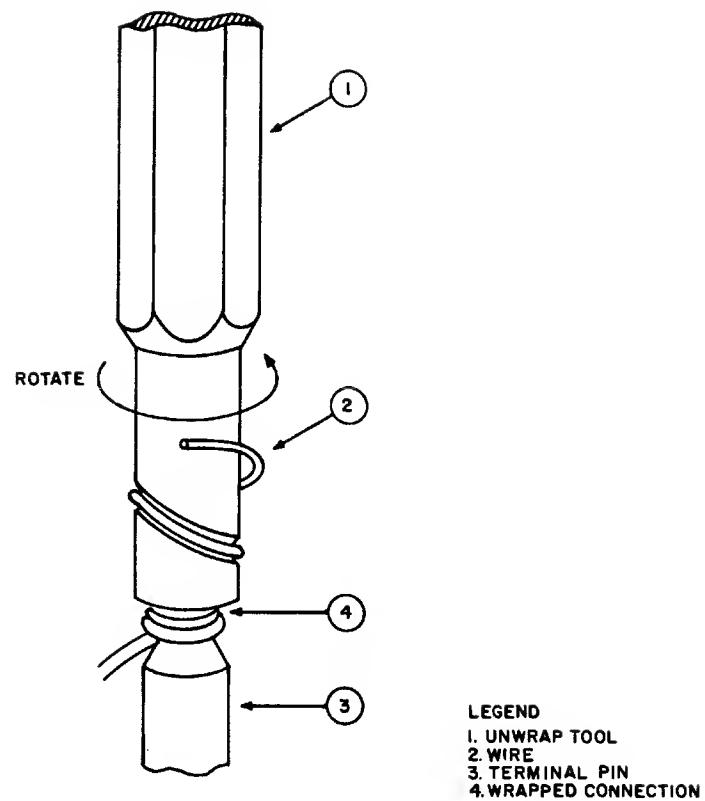
## 2.7 DRESSING FINGERS

The dressing fingers (Figure 2-4) are sleeves that can be slipped over a terminal pin. They can be used to keep sight of a wire that has already been identified and to route wires correctly and cleanly around the pins.



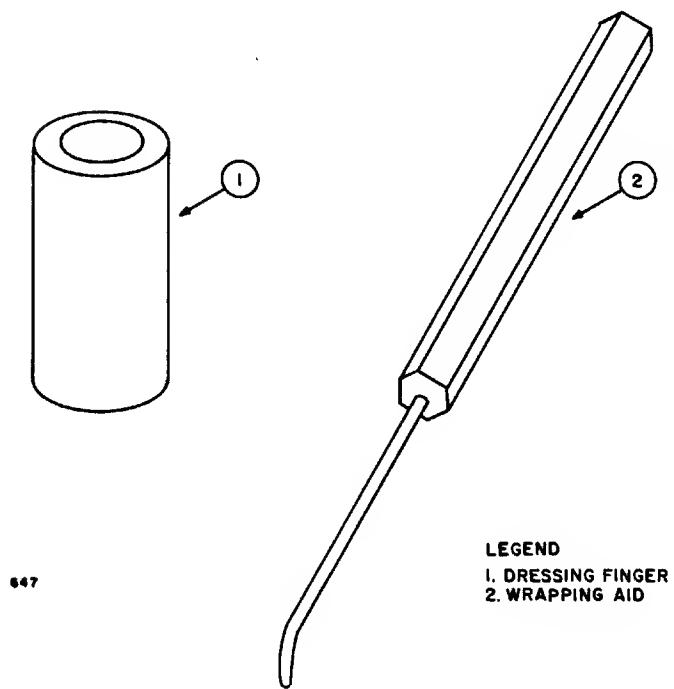
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Figure 2-2. Wire-Stripping Tool



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Figure 2-3. Wire Unwrap Tool



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Figure 2-4. Small Tools for Wrapping

## 2.8 TWEEZERS AND WRAPPING AID

These tools are occasionally required to aid in dressing the wire between the terminal pins. (Refer to Figure 2-4 and Section III of this manual.)

## 2.9 DUMMY CONNECTOR

The dummy connector (Figure 2-5) is used to help the operator gain experience in wrapping techniques before working on the final product. One dummy connector is included in each kit.

## 2.10 RULER

A 6-inch ruler is used to measure the cutting length of wire stripped on one end only.

## 2.11 PRECUT AND PRESTRIPPED WIRE

Precut and prestripped wire may be procured from Computer Control Company, Inc. in the following lengths (given in inches).

Both ends stripped: 2-5/8, 2-3/4, 2-7/8, 3, 3-1/8, 3-1/4, 3-3/8, and 3-1/2

One end stripped: 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, and 26

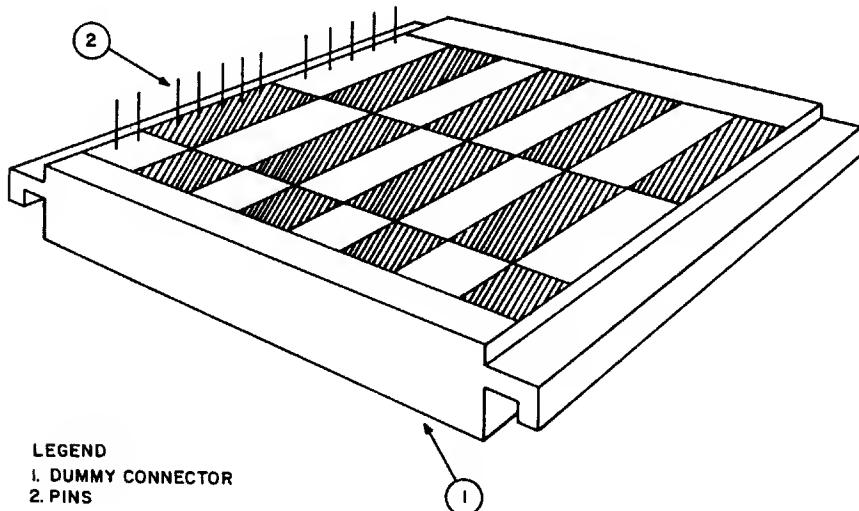


Figure 2-5. Dummy Connector

## 2.12 WRAP STATION

Although special fixtures are not required, a work station similar to the one shown in Figure 2-6 is recommended. This configuration places emphasis on proper positioning of the panel, location of tools and wire, and adequate light intensity. Thus, the operator will be able to work steadily with a minimum of fatigue.

The panel should rest on the horizontal rail (not tied down on the table), and the connector plane should be at 20° inclination away from the operator. Prestripped wire is stored along the left-hand side of the board. A fluorescent light source of approximately 150-foot-candle intensity should be located above and behind the top edge of the panel.

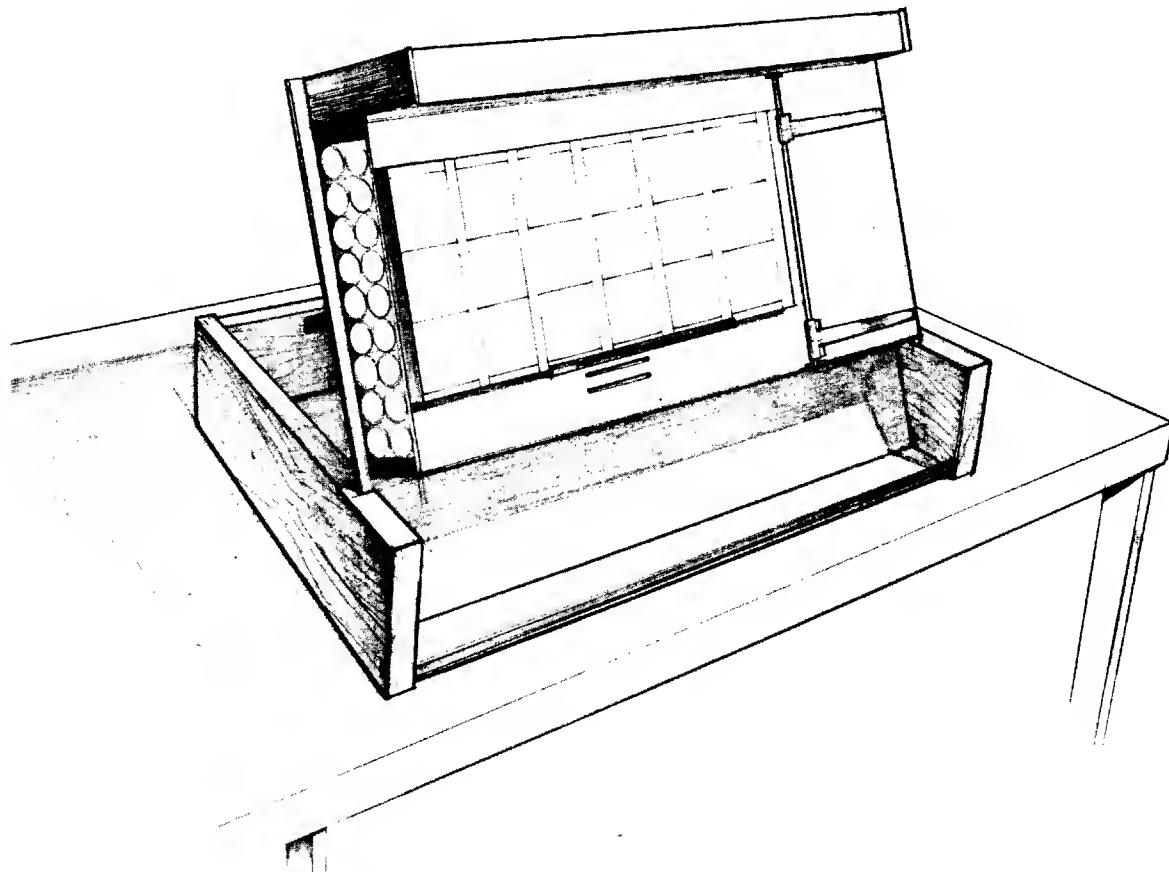


Figure 2-6. Recommended Work Station Configuration

## 2.13 TOOL MAINTENANCE

The tools described in this section require only a periodic check (after each 5000 connections) for proper functioning. The battery-operated wrapping tool is lubricated for life.

The unwrap test described in Section IV can be used to check if cold working of the wire has occurred as a result of the wire being wrapped too tightly. In addition, the pull test described in Section IV will indicate if sufficient tension is being applied during the wrapping operation.

### NOTE

Careful handling of the tools is mandatory to ensure proper operation.

## SECTION III INSTRUCTIONS FOR THE OPERATOR

### 3.1 INTRODUCTION

Before attempting to wrap the final product, the operator should observe the following general procedures.

- a. Having read this manual in its entirety, become thoroughly familiar with the mounting assembly. Refer to paragraphs 1.3 and 1.4, observing pin locations as shown on Figure 1-2. Note the relationship of the bus pins at the bottom of the connector to the checker-board configuration.
- b. Review tool descriptions given in Section II of this manual.
- c. Review Paragraphs 3.3, 3.9, and 4.2 and Figures 3-1 and 4-1 in order to obtain a thorough understanding of the general characteristics of a good mechanical, electrical wrapped connection.
- d. Follow instructions given in Paragraphs 3.2 through 3.8, making at least 10 connections between pins on the dummy connector. Beginning with a pin distance of one, continue to increase the distance between pins. Make more than one wrap per pin, increasing to a total of three.

### 3.2 WIRE SELECTION

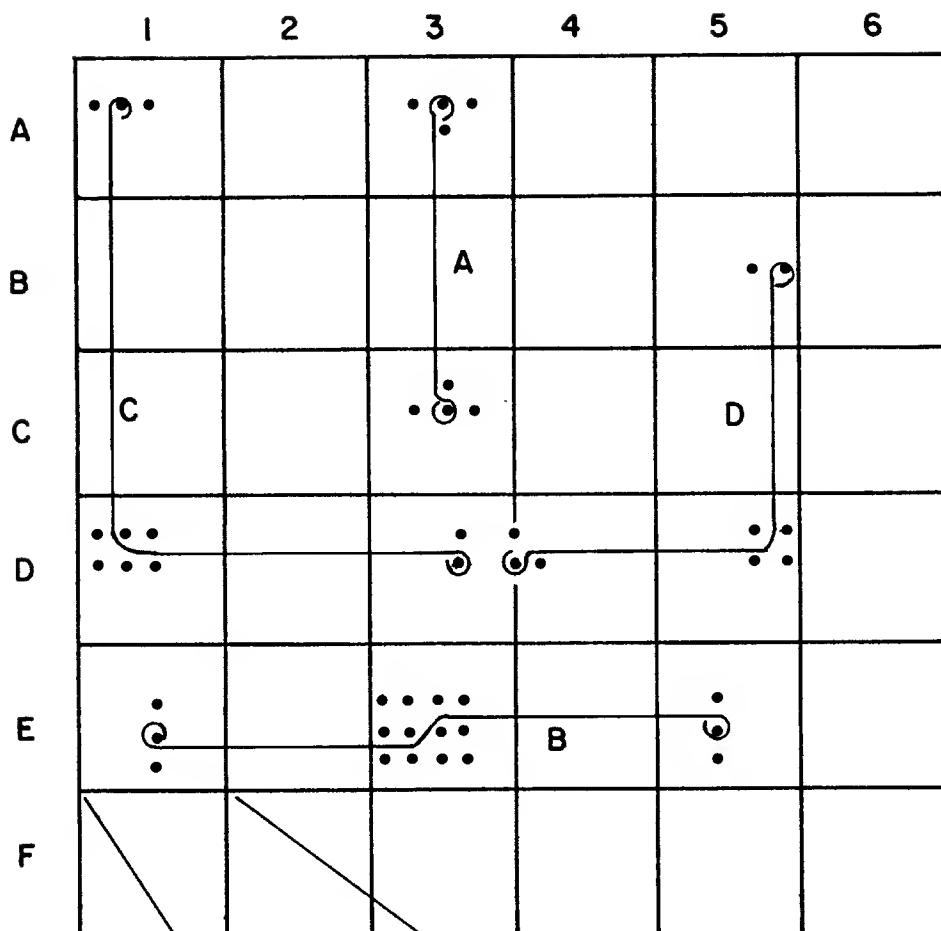
To select the correct wire for wrapping, proceed as follows.

- a. Locate pins to be wrapped.
- b. Slip dressing fingers over "To" pins, "Via" pins and "From" pins, depending upon location of pins and distance between them.
- c. If the distance between the "To" pin and the "From" pin is less than one inch, use wire that is prestripped on both ends, in accordance with Figure 3-1. If the distance between the pins is greater than one inch, use wire that is stripped on one end only. After counting the number of pins passed while routing a wire (including "To" pin and "From" pin), the wire length may be determined from Figure 3-1 or as follows:

Wire length = (Number of pins -1) x 1/8 + the Adder from Figure 3-1 or,

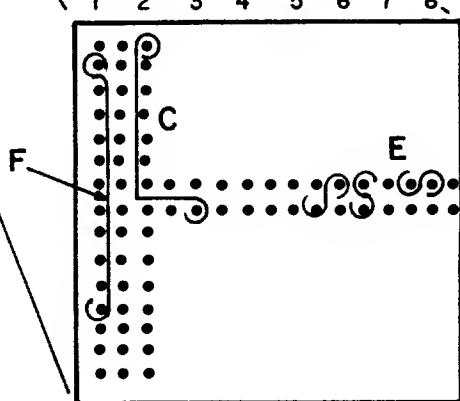
Wire Length = Length of run + the Adder from Figure 3-1.

## CONNECTOR PLANE



### WIRE-LENGTH

	A	B	C	D	E	F	DISTANCE	+	2	1/2
A	"	"	"	"	"	"	"	"	2	5/8
B	"	"	"	"	"	"	"	"	2	1/2
C	"	"	"	"	"	"	"	"	2	3/8
D	"	"	"	"	"	"	"	"	2	1/2
E	"	"	"	"	"	"	"	"	2	1/2



## CONNECTOR ASSEMBLY

Figure 3-1. Recommended Wire Length (Prestripped at Both Ends)

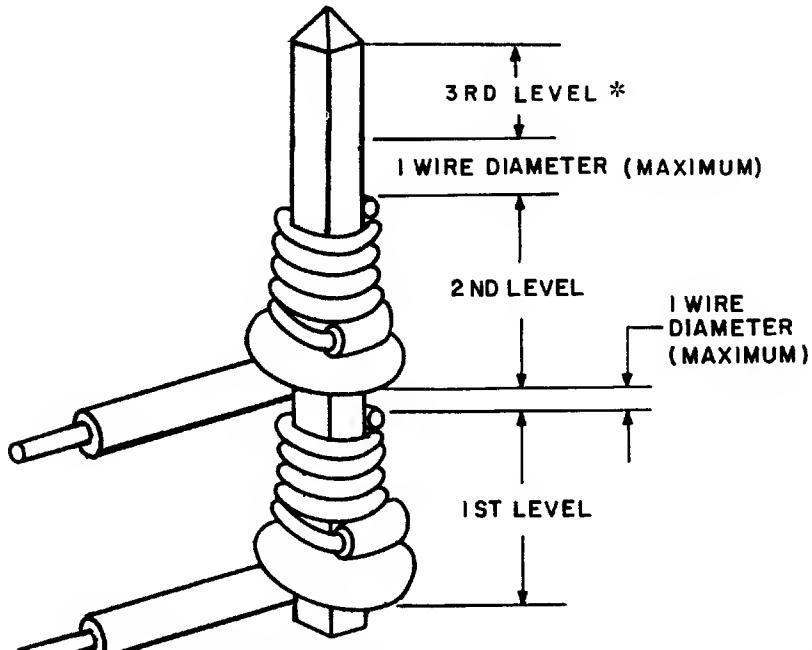
### 3.3 CONNECTION POSITIONING

The following paragraphs describe proper positioning of the wrapped connection on the terminal. Figure 3-2 indicates correct positioning and dimensional limits applicable to first-level and second-level connections.

The first-level (bottom) connection should be positioned as closely as possible to the base of the terminal. In any case, the connection should not diminish the effective wrapping length of the terminal such that additional connections could not be made.

The second-level connection should be positioned so that no portion of the wrap extends beyond a minimum of one wire diameter (0.010 in.) below the apex of the terminal.

The spacing between any two connections on the same terminal should be a maximum of one wire diameter (0.010 in.).



\*The third level should be used only where necessary as it will make wiring changes at lower levels more difficult.

Figure 3-2. Connection Positioning

### 3.4 WRAPPING PROCEDURE (POWER "WIRE-WRAP" TOOL)

The procedure for wrapping with the power "Wire-Wrap" tool is as follows.

- a. Insert stripped wire into the smaller of the two holes at the bit end of the wrapping tool. In this position, approximately 1/4 in. of insulated wire length will also be inside the hole. (See Figure 2-1.)
- b. Bend the wire (insulated portion) outside the tool 180 degrees upward and parallel to the sleeve. The bend should sit in the sleeve notch closest to the direction from which the wire will run.
- c. Grasp the wire firmly at least 1/4 in. from the tool end, and align the large hole in the wrapping tool with the terminal pin.
- d. Slide the tool over the pin until it comes up against the base of the connector.
- e. Maintain light tension on the wire, ensuring that the bend remains in the sleeve notch. If necessary, make use of the "Wire-Wrap" aid.
- f. Activate the tool for approximately 2 seconds. This should complete the wrap around the pin (see Figure 4-1).
- g. Slide the tool off the terminal pin.
- h. When making a second-level wrap, insert the wire as described previously and push the wrapping tool over the pin until it comes up against the first wrap. Back off approximately 1/16 in. and insert the wrapping aid between the first-level wrap and the "Wire-Wrap" tool. Ensure that the 180-degree bend is in the correct notch in the "Wire-Wrap" tool sleeve. Proceed with steps (f) and (g) above.

### 3.5 WRAPPING PROCEDURE (MANUAL "WIRE-WRAP" TOOL)

When using the hand-operated tool, proceed as follows.

- a. Insert the tool over the pin as described in Paragraph 3.4. However, since both sleeve and bit rotate in this case, there are no notches in the sleeve.
- b. Hold the wire stationary by means of the wrapping aid and rotate the handle approximately 12 turns. Apply slight axial pressure on the tool while rotating the handle.

### 3.6 ADJACENT PIN WIRE WRAPPING

Use the following recommended procedure to connect pins that are adjacent to each other.

- a. Using a wire 2-5/8 in. long, wrap one pin as indicated in paragraphs 3.4 and 3.5.
- b. Run wire to designated adjacent pin. Use wrapping aid to hold wire in place at base of pin already wrapped.
- c. Bend wire upward at base of pin to be wrapped (wire runs parallel to pin). Ensure that wire is as close to pin as possible and that it is not damaged.
- d. Align wrapping tool above the pin to be wrapped so that the wire is lined up with the small hole and the pin with the large hole.
- e. Slide wrapping tool over wire and pin until tool comes up against the connector base.
- f. When wrapping adjacent pins only, it is acceptable to run connecting wire diagonally as well as horizontally or vertically.

### 3.7 WRAPPING DOUBLE-ENDED PRESTRIPPED WIRE

Proceed as follows to wrap double-ended prestripped wire.

- a. Use oversized wire to measure the distance between pins to be connected.
- b. Use prestripped wire (one end only) which is at least 2-5/8 in. longer than measured distance.
- c. Lay the wire along intended path as shown in Figure 3-3.
- d. Cut wire to 1-5/16 in. beyond the "To" pin (see Figure 3-3).
- e. Strip 1-1/16 in. from the unstripped end.
- f. Wrap the "From" pin.
- g. Route wire to the second pin and wrap.

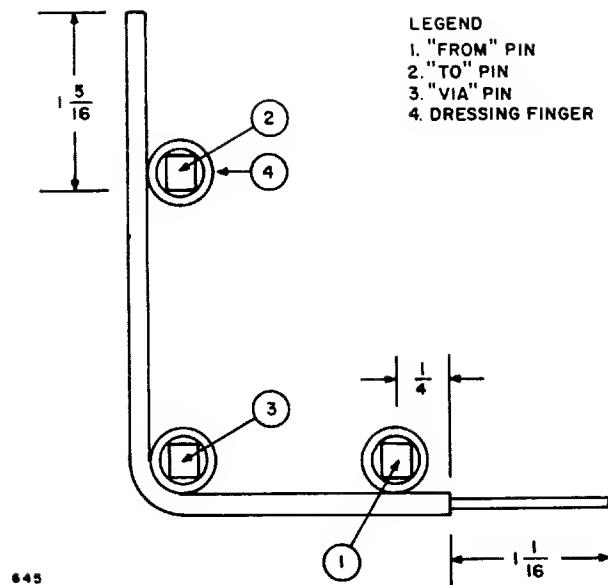


Figure 3-3. Wire Measurement and Routing

### 3.8 WIRE STRIPPING

To strip insulation from wire, proceed as follows.

- a. Insert wire between clamping pads and stripping blades until wire contacts reaches the bottom of the hold in the adapter (see Figure 2-2).
- b. Ensure that wire falls into notch marked "30" (extreme right as viewed from adapter side).
- c. Release handle quickly but steadily and, at the same time, pull wire from stripper (opposite direction from insertion).

### 3.9 WIRE ROUTING AND DRESSING

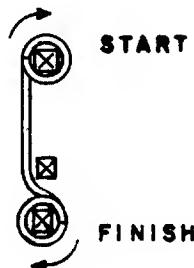
The wire may be routed from pin to pin in a number of different ways. When large panels are to be wired or, if there are many of the same type, the following procedure is recommended.

- a. Identify the "From," "To" and "Via" pins (see Figure 3-3) for the operator.
- b. Establish a limit of two connections per pin (first and second level). Make all first-level connections before proceeding to the second level.

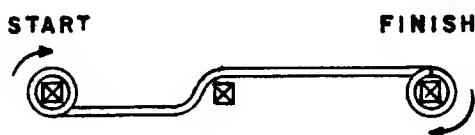
Layout of all wiring should be as neat and short as possible without causing congestion of wires in any area. In addition, wire should not be routed across any area required for subsequent assembly. Care should be taken to insure that no section of wire is pulled sharply against a corner of a wrap post where bends in a run are formed.

Each connection should be oriented so that dress of the wire does not tend to unwrap the connection. Refer to Figure 3-4 for an example of acceptable and unacceptable wire positioning. Bends in the wire should have a minimum inside radius of 1/8 in., but in no case should they be made at a sharp right angle. The foregoing requirements will be met if the following precautions are observed.

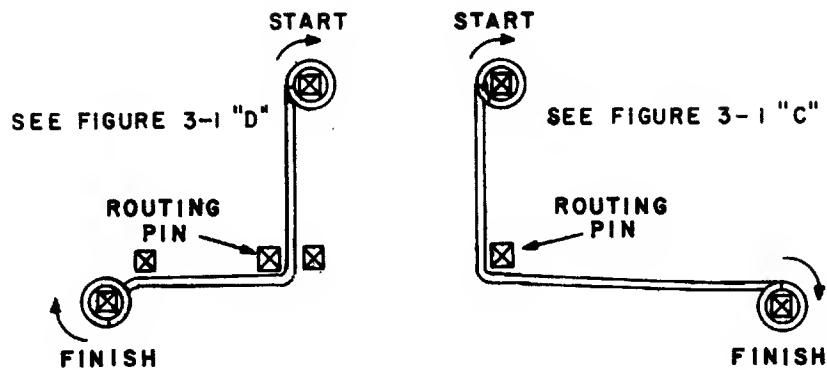
- a. When making a vertical run of wire, start at the top and finish at the bottom.



- b. When making a horizontal run of wire, start at the left and finish on the right.



c. When making an L-shaped configuration start at the upper point and finish on the bottom.



#### CAUTION

Ensure that both wrapped ends of any given wire are on the same level.

d. To minimize system noise, establish routing so that critical wires do not run parallel to each other for long distances.



Figure 3-4. Wire Positioning

## SECTION IV ACCEPTANCE TESTS

### 4.1 INTRODUCTION

This section of the manual describes tests to be performed in order to determine acceptability of wrapped connections. Most of the tests are based on visual inspection, but some destructive tests, using the dummy connector, may be performed if deemed necessary.

### 4.2 WRAP CONFIGURATION

Figure 4-1 illustrates a satisfactory wrap configuration. A good electrical and mechanical connection consists of seven to nine turns of bare wire, and one-half to two turns of insulated wire around the pin. A stripped length of wire measuring  $1-1/16$  in.  $\pm 1/32$  in. should furnish this configuration. In addition, the insulated wire should pass at least two corners of the connector pin. This is called a "modified" wrap and serves as stress relief for the wire.

### 4.3 UNACCEPTABLE CONNECTIONS

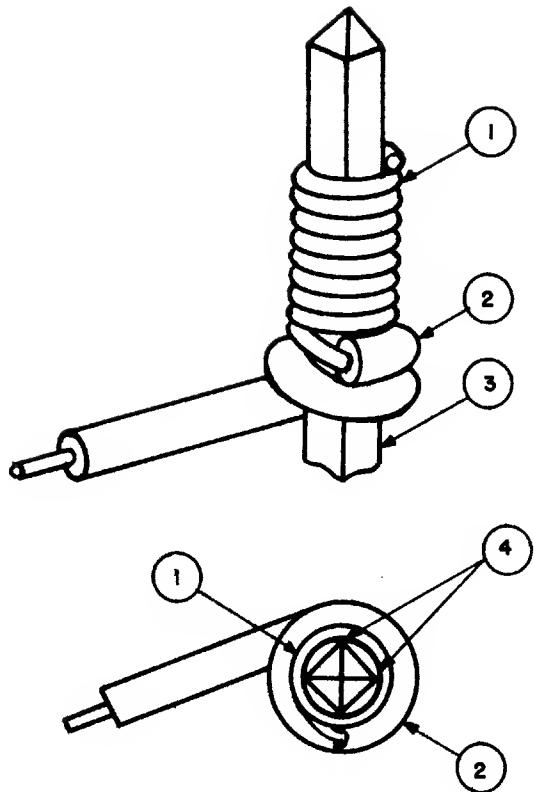
If the instructions given in this manual are not followed carefully, several deviations from the standard, acceptable configuration may result. These unacceptable connections are shown in Figure 4-2.

### 4.4 DESTRUCTIVE TESTS

The following tests may be performed to obtain a reasonably accurate picture of the mechanical and electrical quality of the wrapped connection.

#### 4.4.1 Unwrap Test

Use the unwrap tool (Figure 2-3), as described in Paragraph 2.6, to unwrap the wire from the pin. Transfer all turns from the pin and onto the tool. The wire shall not break during the unwrap operation.



**LEGEND**

- 1 SEVEN TO NINE TURNS BARE WIRE
- 2 ONE HALF TO TWO TURNS INSULATED WIRE
- 3 TERMINAL PIN
- 4 TWO OR MORE PIN CORNERS TOUCHING INSULATED TURNS

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Figure 4-1. Wrapped Connection Configuration

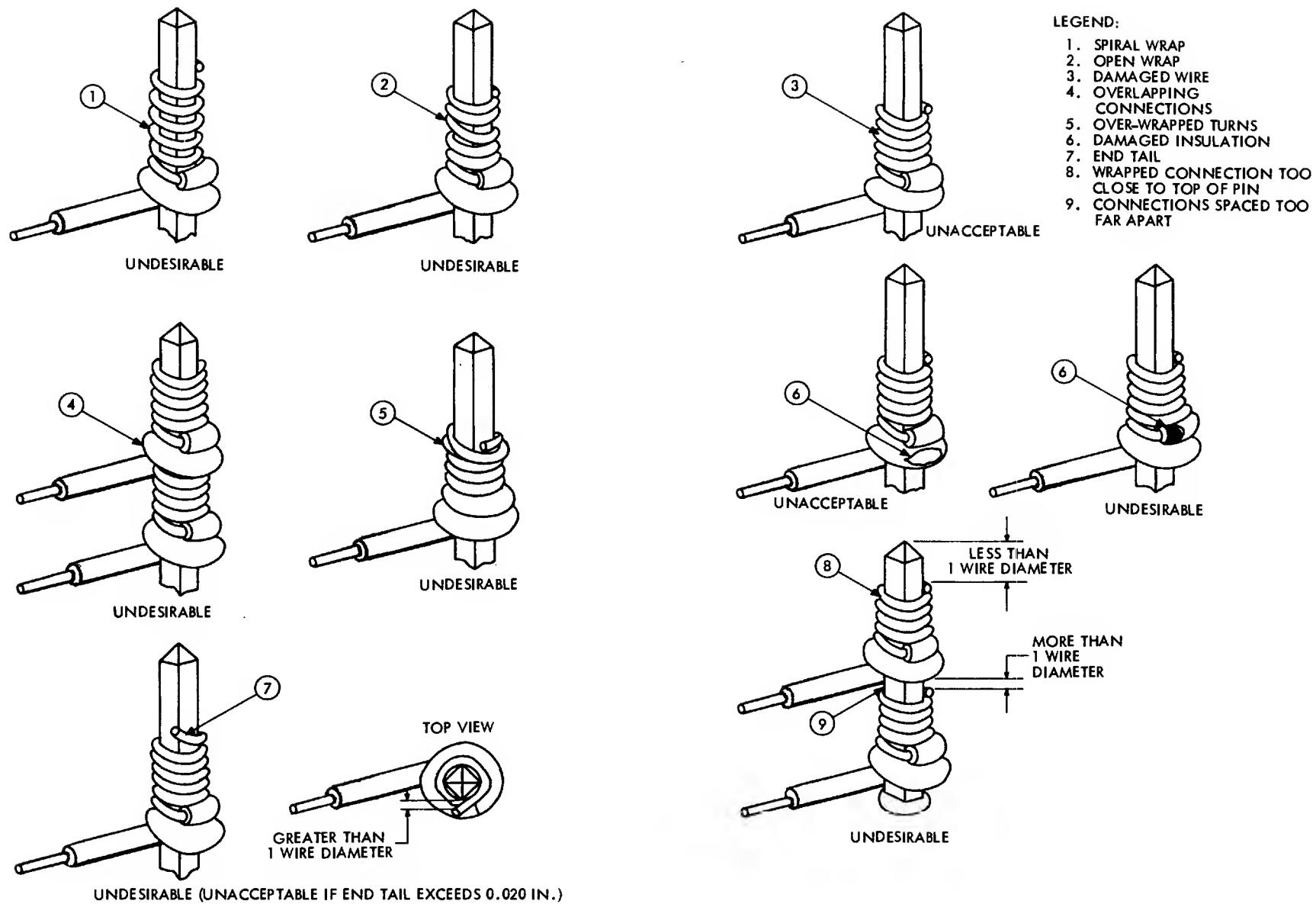


Figure 4-2. Unacceptable Wrapped Connections

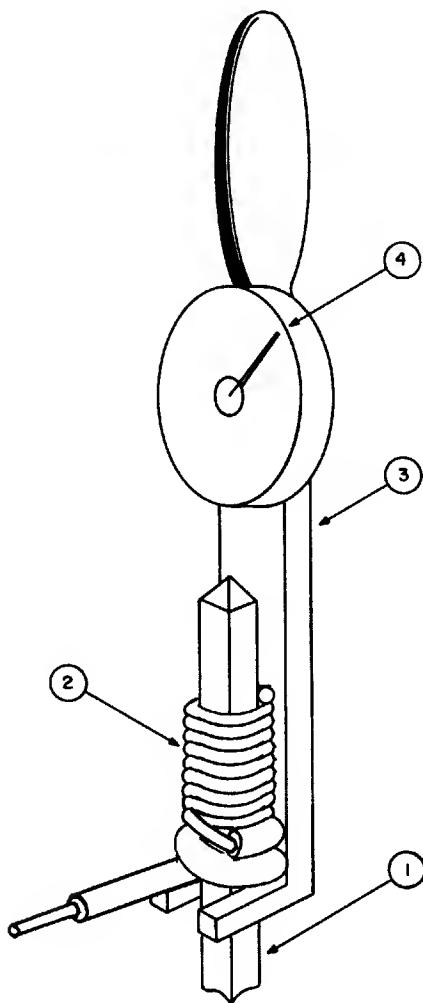
#### 4.4.2 Pull Test

Use a pull tester (Figure 4-3) to remove the wire coil from the pin.

##### NOTE

The pull tester shown in Figure 4-3 is not included in the "Wire-Wrap" kit.

The force (as measured on the gage) required to move the wire coil, relative to the pin, shall be a minimum of four pounds.



##### LEGEND

1. TERMINAL PIN
2. WRAPPED CONNECTION
3. PIN STRIPPING FORCE GAGE
4. DIAL (MUST READ 4 LBS MIN. BEFORE CONNECTION MOVES ON PIN)

Figure 4-3. Typical Pull Tester Configuration

## SECTION V AUTOMATIC MACHINE-WRAPPED WIRING

### 5.1 INTRODUCTION

The Honeywell  $\mu$ -BLOC connector plane may be interconnected by automatic machinery, such as that manufactured by Gardner-Denver Company, Grand Haven, Michigan. There are several service centers throughout the United States operated by Gardner-Denver Company and authorized subcontractors. Honeywell will provide complete information regarding these service centers upon request.

This section of the manual describes procedures to be followed when using automatic wiring machinery.

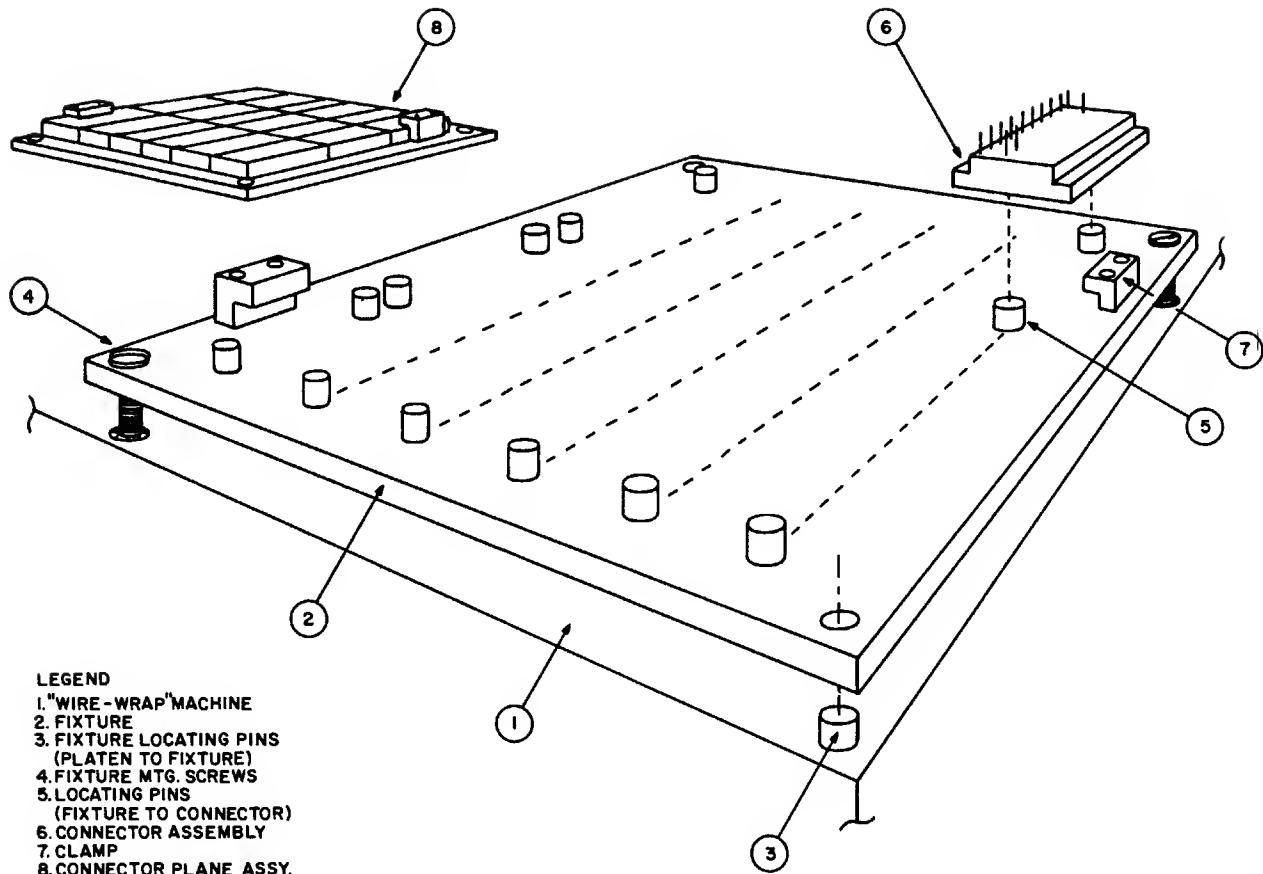
### 5.2 AUTOMATIC "WIRE-WRAP" MACHINES

Two types of machine are available from Gardner-Denver Company. These machines allow wiring on connectors having 0.125 in. center distance between pins. The machines are identified as follows.

- a. Type 14F 15 x 15 x 0.125
- b. Type 14F 15 x 15 x 0.025 (Universal Model)

Both machines require that each connector pin be located within 0.020 in. true position from a common reference point. In order to accomplish this, the extrusion will allow movement of each connector assembly in the wrap plane (see Figure 5-1). A fixture similar to that shown in Figure 5-1 is necessary to locate a given connector assembly correctly relative to another.

Before mounting the connector assemblies, the PAC guides should be removed. The connector assemblies are then mounted on the fixture with clamps, as shown in Figure 5-1. The pins slide into the holes in each connector assembly, thus positioning each assembly within the required tolerances. The tolerances are as follows.



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Figure 5-1. Wiring Machine Fixture

- a. Terminal pin in connector:  $\pm 0.012$  in.
- b. Connector holes - locating pin:  $\pm 0.012$  in.
- c. Fixture tolerances:  $\pm 0.002$  in.
- d. Gardner-Denver Company machine tolerances:  $\pm 0.005$  in.

### 5.3 SERVICE CENTERS

The following is a list of possible service centers for automatic "Wire-Wrap" machines.

- a. RCA, Cambridge, Ohio
- b. Raytheon, Waltham, Massachusetts
- c. Gardner-Denver Company, Grand Haven, Michigan
- d. Cubic Corporation, San Diego, California
- e. Automatic Electric Company, Chicago, Illinois

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